# Current thrusts of the World Climate Research Programme

Vladimir Ryabinin (Joint Planning Staff for WCRP)

# World Climate Research Programme (WCRP)

**Objectives**

- ♦ **To determine the predictability of climate**
- ♦ **To determine the effect of human activities on climate**

**Sponsors:**

**World Meteorological Organization (WMO, since 1980),**

**International Council for Science (ICSU, since 1980), and**

**Intergovernmental Oceanographic Commission (IOC) of UNESCO (since 1993)**

# World Climate Research Programme (WCRP)

**Objectives**

- ♦ To determine the predictability of climate
- ♦ To determine the effect of human activities on climate

  \+ (?)

- ♦ Science supporting
  - impact and vulnerability assessment,
  - adaptation, and
  - and mitigation to climate change

**Way WCRP does its business**

# WCRP Environment (1)

## World Climate Programme

### Coordination of climate-related activities and support to IPCC, UNFCCC and other Conventions

### WCASP
World Climate Applications and Services Programme & **CLIPS**

**Goals:**

- develop climate services
- increase awareness of benefits
- develop practical product methods
- increase utilization of information & predictions

### WCDMP
World Climate Data and Monitoring Programme

**Goals:**

- improve databases & data management
- improve climate system monitoring efforts & awareness
- develop new data techniques for rescue

### WCRP
World Climate Research Programme

**Goals:**

- determine the predictability of climate
- determine the effect of human activities on climate

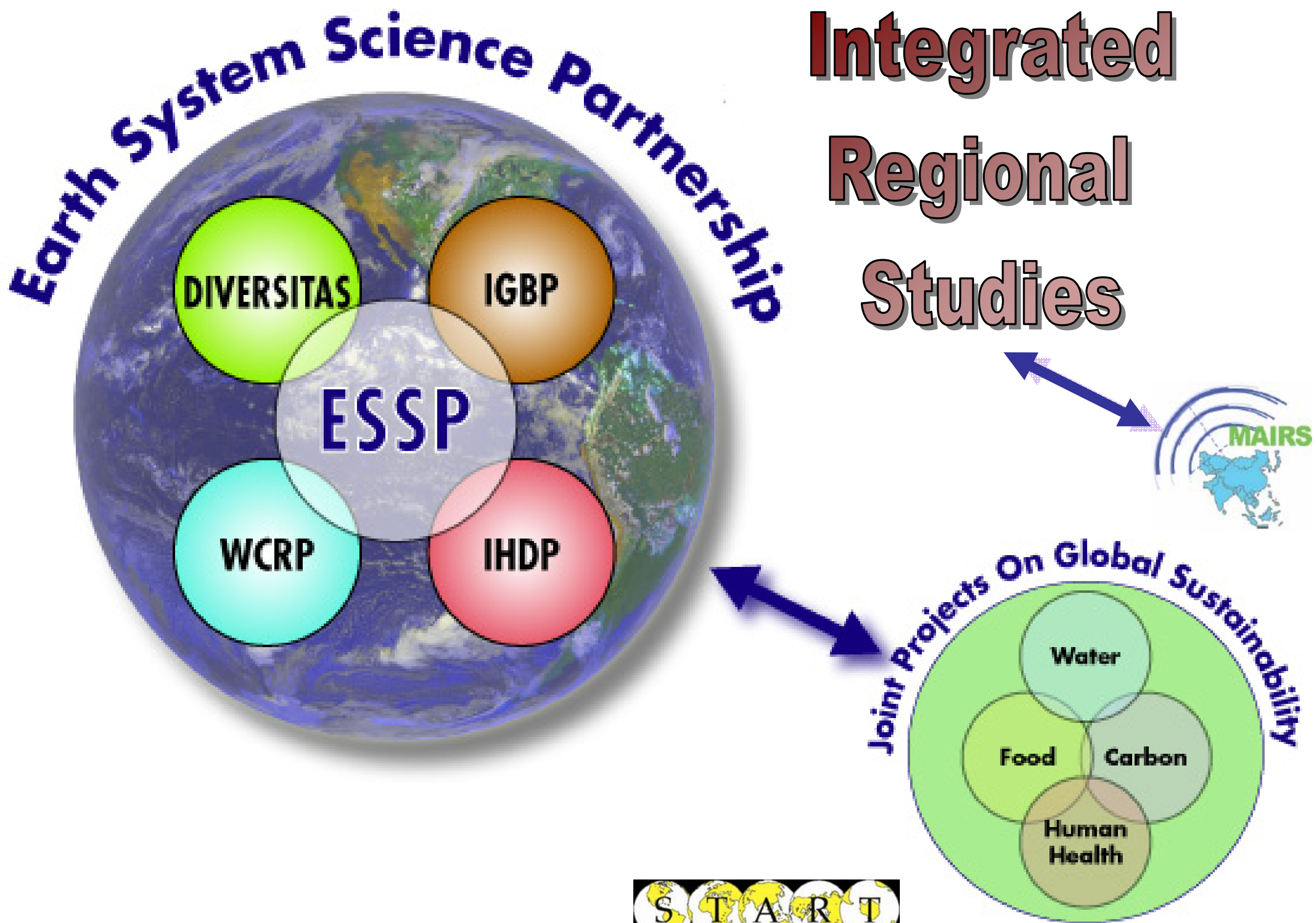
### WCIRP
World Climate Impact Assessment and Response Strategies Programme

**Goals:**

- assess impacts of climate variability and change
- develop socio-economic response strategies
- assess air quality and pollution mitigation strategies

# WCRP Environment (2)

## Earth System Science Partnership




www.essp.org

START IHDP • IGBP • WCRP

# Where the climate science has to deliver

**Long-term prediction:**

MRF -> Seasons -> Decades

Seamless prediction problem

**Anthropogenic climate change (ACC):**

Scenario based projections

Impact & risk assessment

Adaptation

Nairobi WP

Mitigation

Post-Kyoto

**Applications: multiple**

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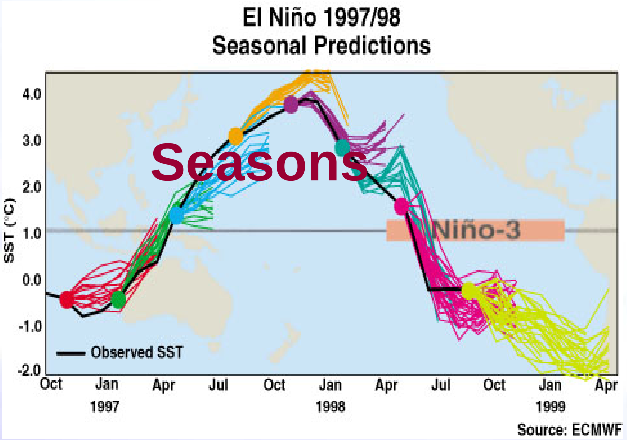
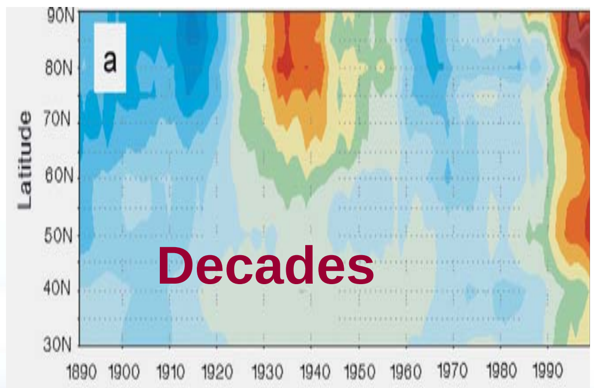
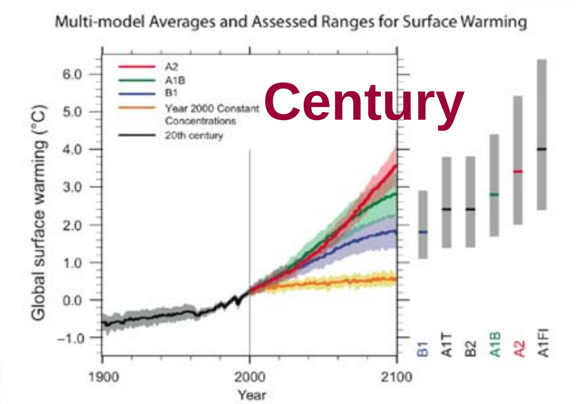
WCRP World Climate Research Programme

# Challenge in terms of time scales in climate prediction




Initial value problem. Applications on the rise.

Scope: Variability originating mostly from tropics. Predominantly "physical" domain, upper ocean crucial, El Nino-(Pacific Ocean) based.

Hard: combines the two challenges. Predictability not yet known.

Scope: closer to Earth System.

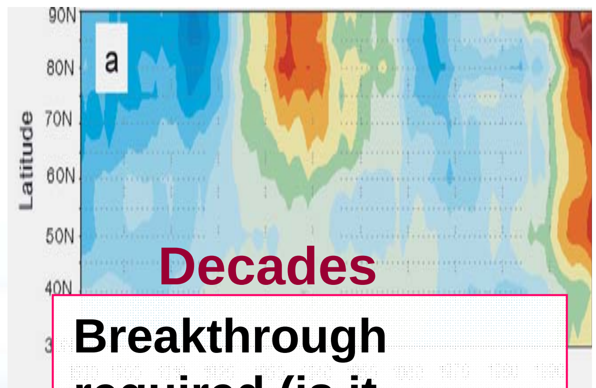
Domain: physics including deeper ocean + some BGC

Forcing by emissions. Initial conditions not so crucial. IPCC AR4: "Climate change unequivocal."

Scope: Earth System including human dimensions.

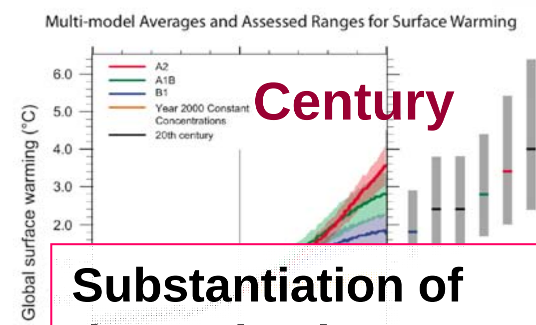
# Challenge in terms of time scales in climate prediction


**Operationalisation, turning bits and pieces of knowledge and skill into a global system, creating quasi-operational environment similar to the one of NWP but going beyond the traditional meteorological domain, adding sources of predictability**




**Breakthrough required (is it possible?) in studying predictability on decadal scales and of regional modes of atmospheric circulation**

Domain: physics including deeper ocean + some BGC

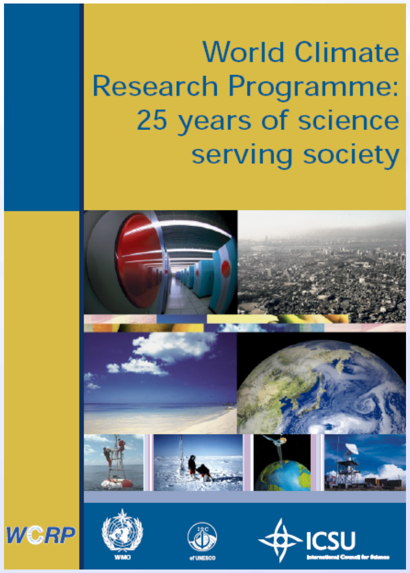



**Substantiation of the projections, inclusion of all necessary feedbacks, full carbon cycle, improvement of representation of the water and energy balance in climate models**

dimensions.

# Coordinated Observation and Prediction of the Earth System, the WCRP Strategic Framework for 2005-2015

To facilitate prediction of Earth System variability and change for use in an increasing range of practical applications of direct relevance, benefit and value to society




**Expect an implementation plan for COPES**

GEWEX 1988 →

IGOS water

SPARC 1992→

CliC 2000 →

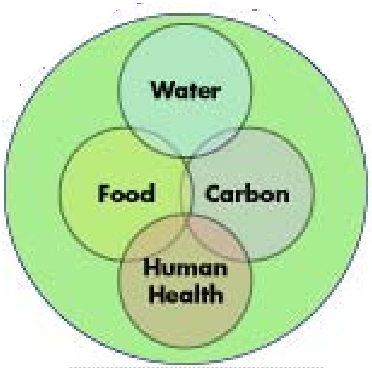
IGOS cryo

- Anthropogenic Climate Change
- Monsoons
- Extreme Events
- Seasonal Prediction
- Decadal Predictability
- Sea-Level Change
- Atm. Chemistry and Climate
- International Polar Year

WCRP

SOLAS 2001 ->

CLIVAR 1995 →




WMP

WOAP

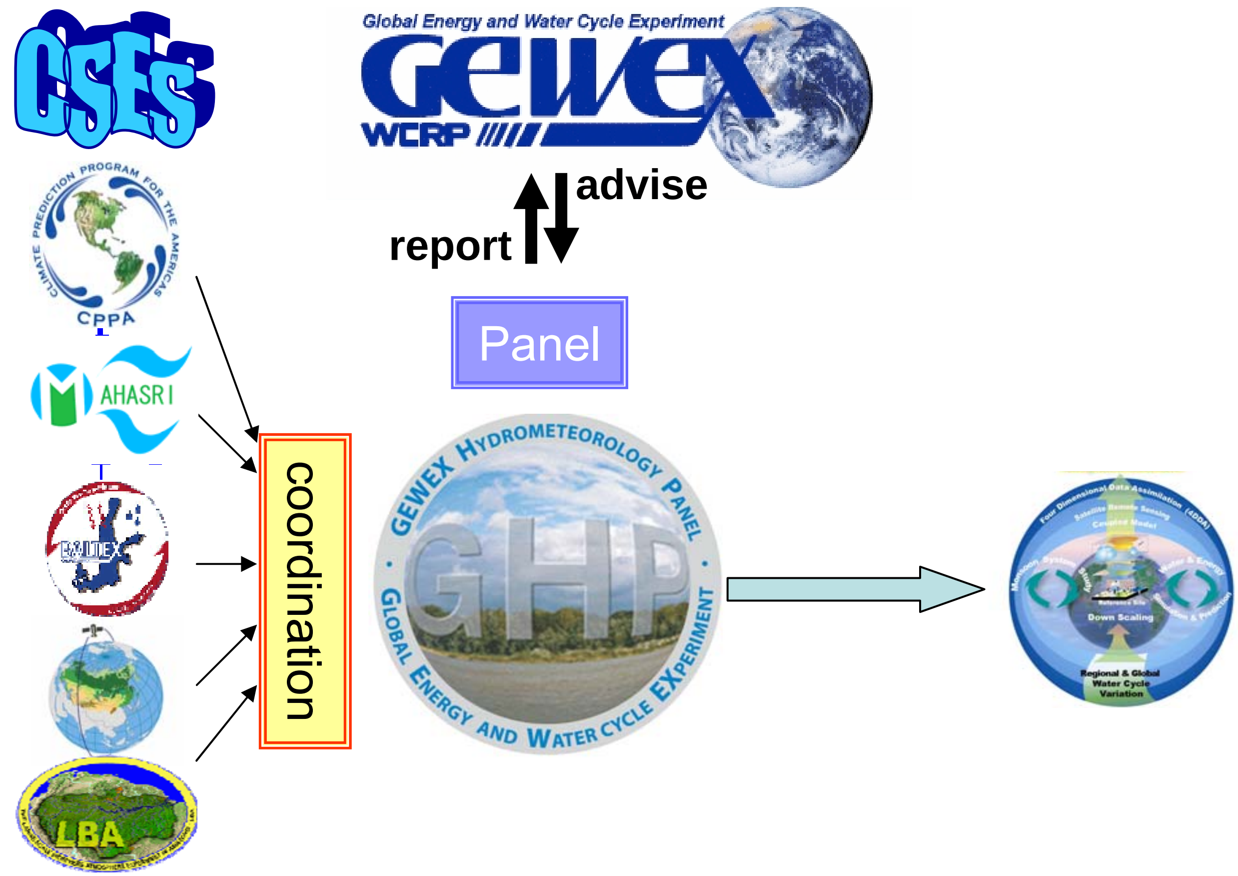
WGNE

A O(T) -OPC

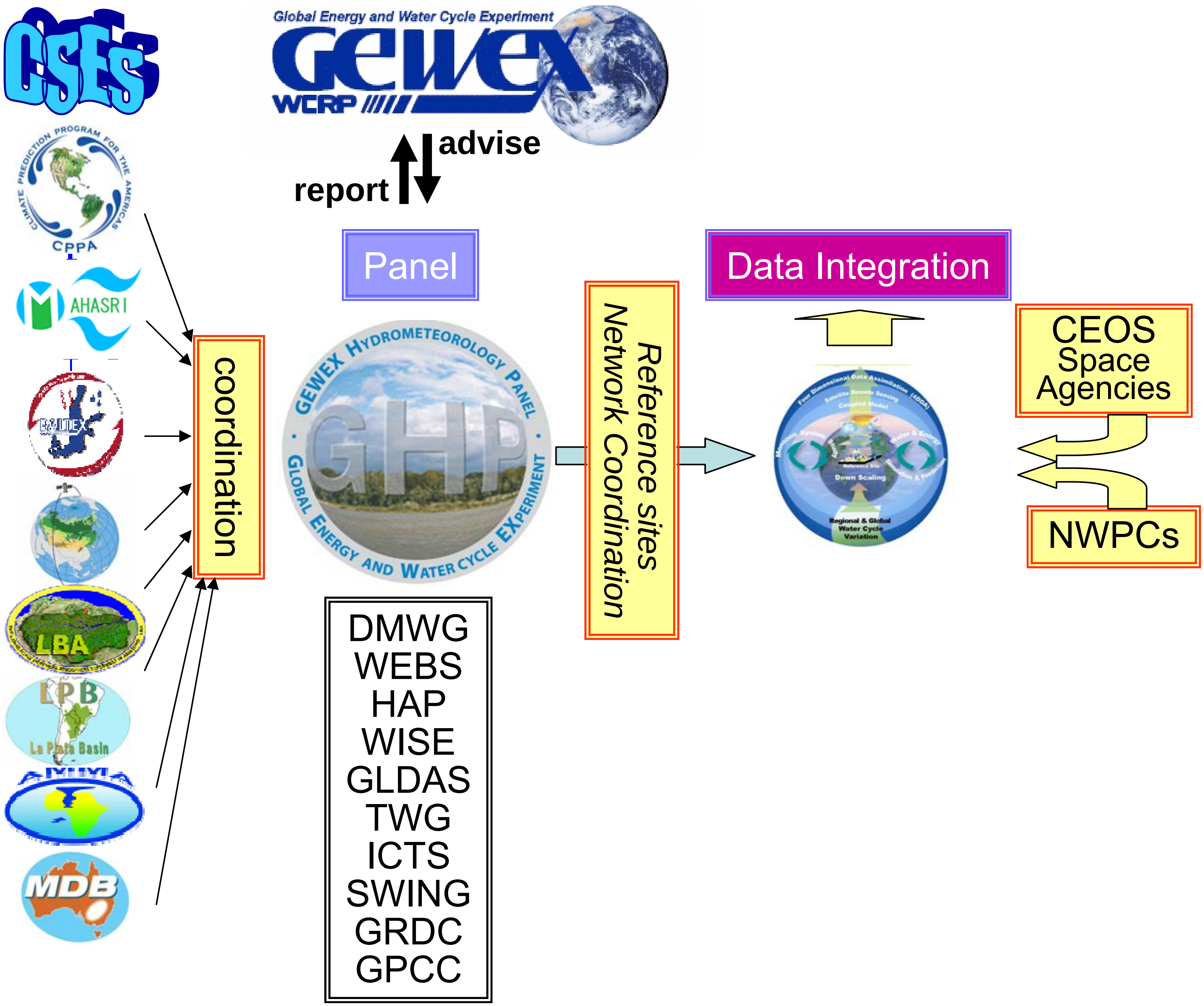
WGSF

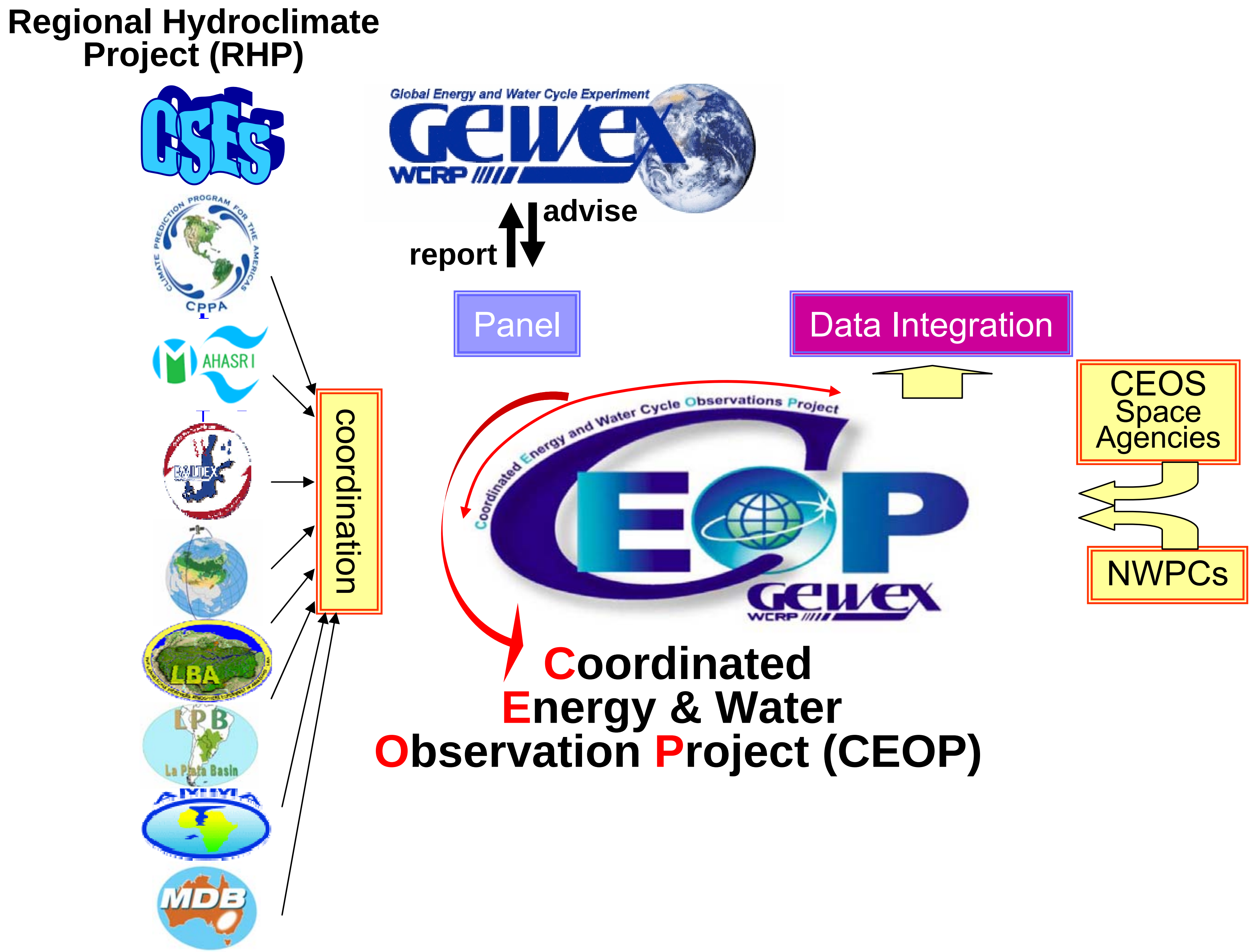
WGCM ocean

# Regional Hydroclimate Project (RHP)



# Regional Hydroclimate Project (RHP)





Regional Hydroclimate Project (RHP)
CSEs
Global Energy and Water Cycle Experiment
GEWEX
WCRP
advise
report
Panel
Data Integration
coordination
CEOS Space Agencies
NWPCs
Coordinated Energy and Water Cycle Observations Project
CEOP
CPPA
AHASRI
LBA
LPB
La Plata Basin
MDB
Coordinated Energy & Water Observation Project (CEOP)

# “Seamless” prediction

**Hypothesis: the Earth System exhibits a wide range of physical, BGC and other phenomena that result in a continuum of temporal and spatial variability and this can be exploited to detect predictability on all scales from days through decades.**

**Current interest on scales from one week to 1-2 months: ensemble forecasting, work with THORPEX, assumed predictability on 10– to 90– day range linked to MJO, hence focus on organised tropical convection and tropical – extratropical interactions.**

# Seasonal Forecasting

Successes: ensemble techniques, empirical methods.

Weak points: intra-seasonal.

Predictability: tropical influences, ENSO, nothing else, really.

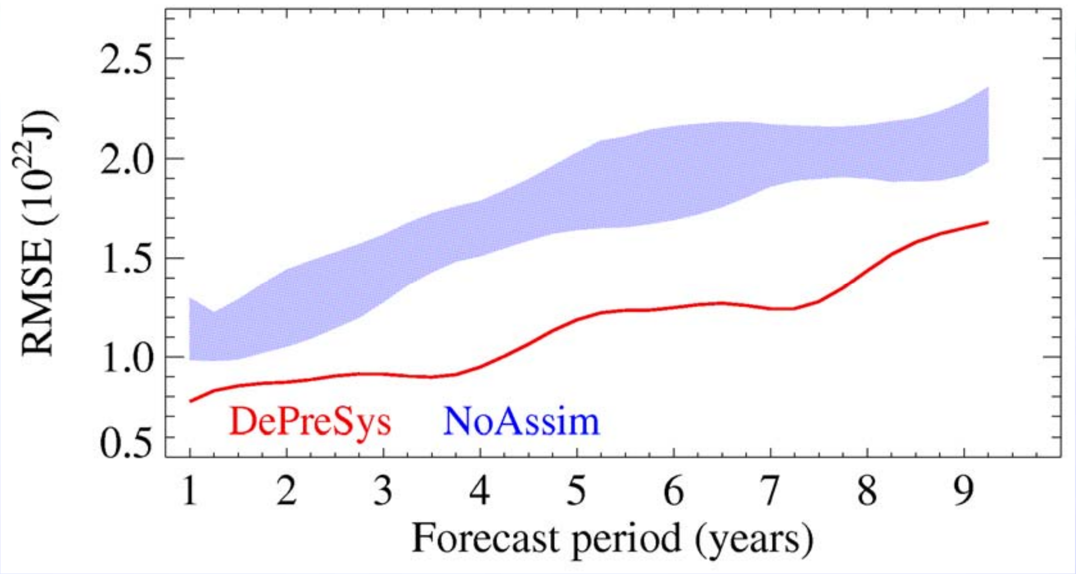
Factors perspective for predictability:
Cryosphere (sea ice and snow cover anomalies, e.g. over Eurasia)
Soil wetness
Vegetation (e.g. leafiness)
Stratosphere

TFSP Experiments: controlled initial conditions versus random

Progress on seasonal forecasts verification

Decadal Climate Predictions at the Hadley Centre (UKMO)
Doug Smith, James Murphy, Stephen Cusack

- A decadal prediction system (**DePreSys**) has been built
- Do we achieve additional skill by starting the model from observed initial conditions ?



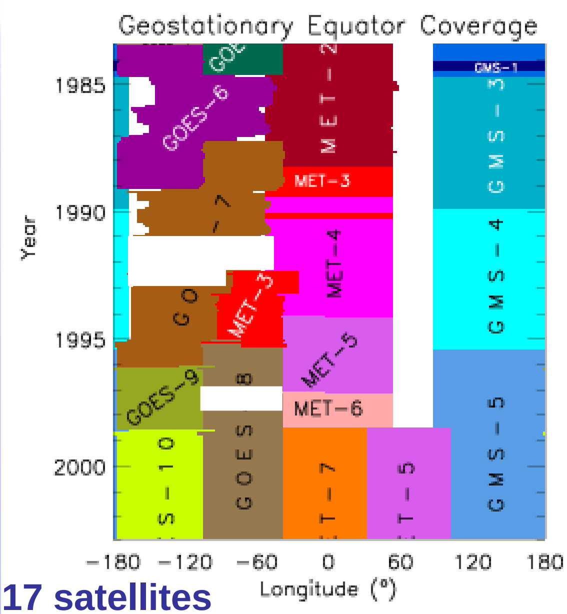

# Proposal for Coordinated WCRP coupled model experimentation (T. Palmer)

# Reanalysis

**Towards climate system reanalysis**

**Reprocessing**

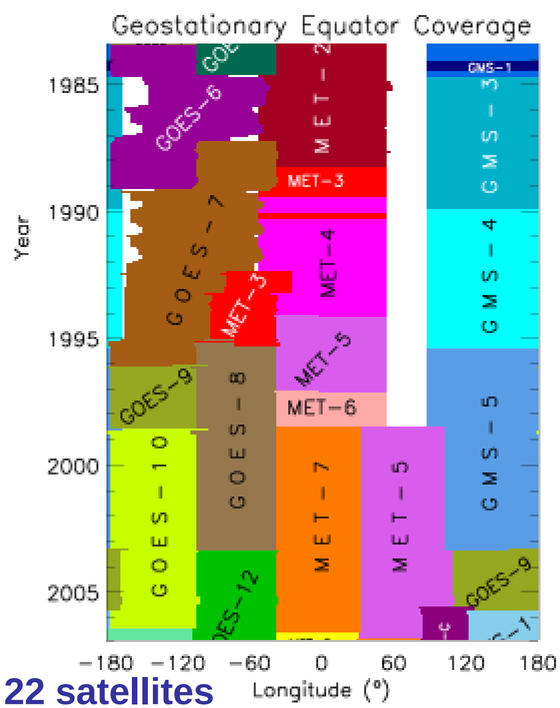
B1 Status - 2003




**17 satellites**

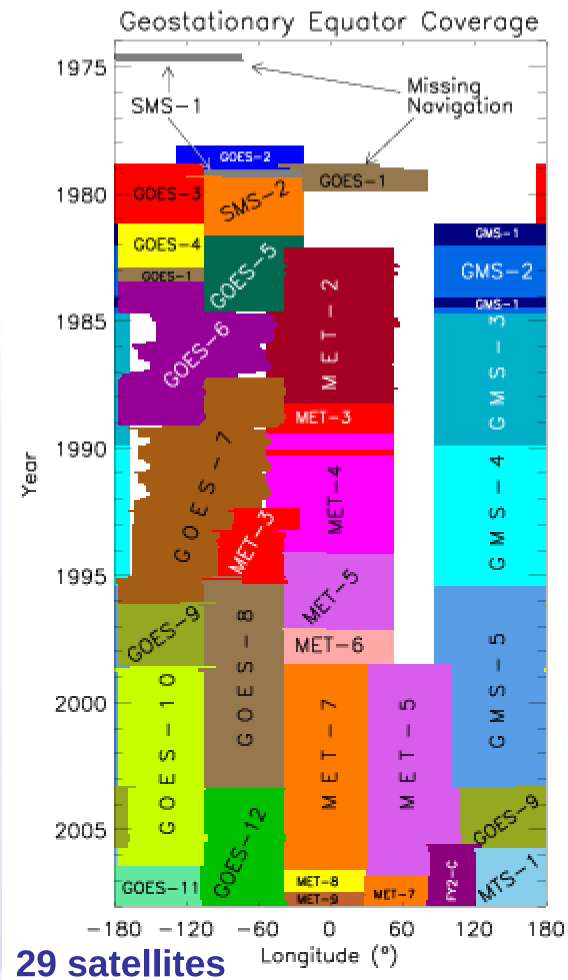
(W. Rossow, NASA)

B1 Status - 2006




**22 satellites**

B1 Status - 2007




**29 satellites**

# Models

Plans for operational global forecasting systems resolutions (from WGNE 'Overview of plans at NWP Centres with Global Forecasting Systems, Jan 2008')

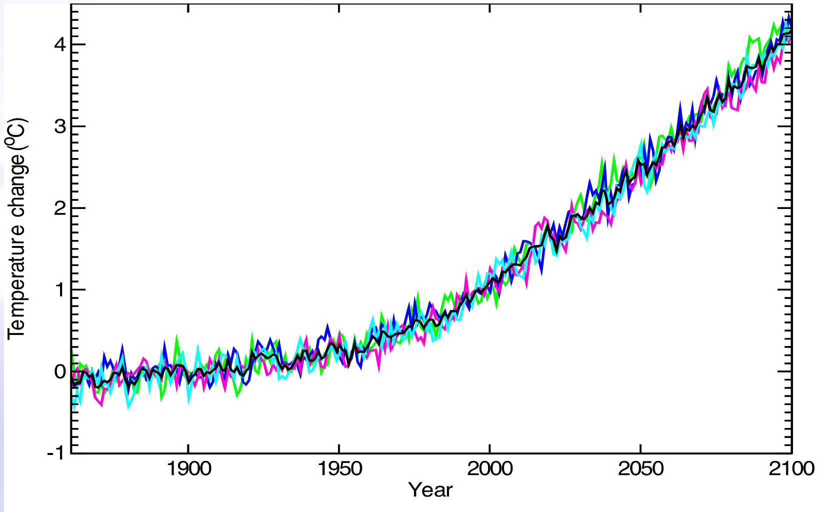
| | | |
|---|---|---|
| **Canada** | **2010** | **25 km/L80 (Currently 35km)** |
| **ECMWF** | **2009** | **16 km/L91 ( 25km)** |
| **Germany** | **2009** | **20 km/L60 (40km)** |
| **Japan** | **2007** | **20 km/L60** |
| **UK** | **2009** | **25 km/L90 (40km)** |
| **USA** | **2010** | **25 km/L90 (~35km)** |

(Courtesy Martin Miller, ECMWF)

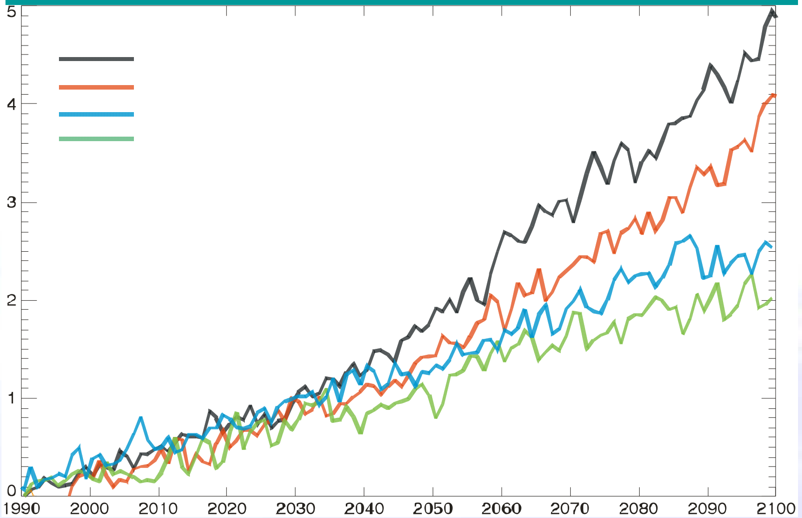
**( Similar plans for several other centres also)**

# Uncertainty in climate predictions

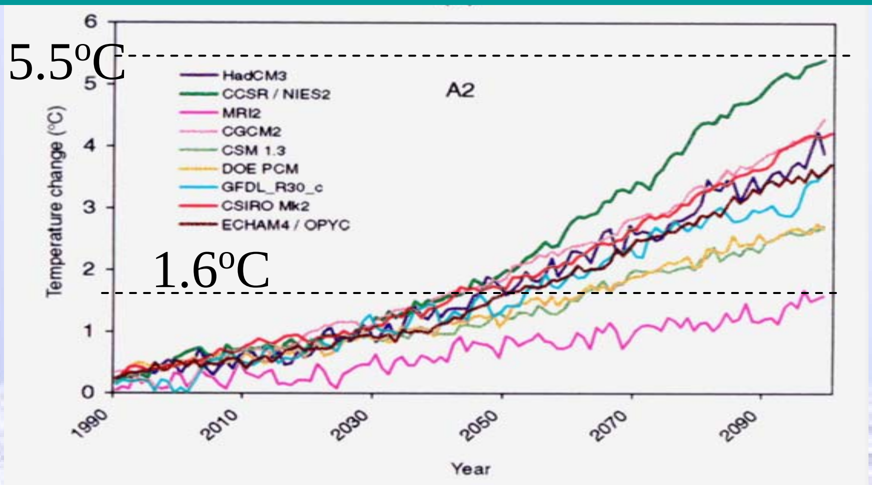
## Effects of natural variability




## Future emission scenarios




## Modelling of Earth system processes




TAR

***Cubasch et al., 2001***



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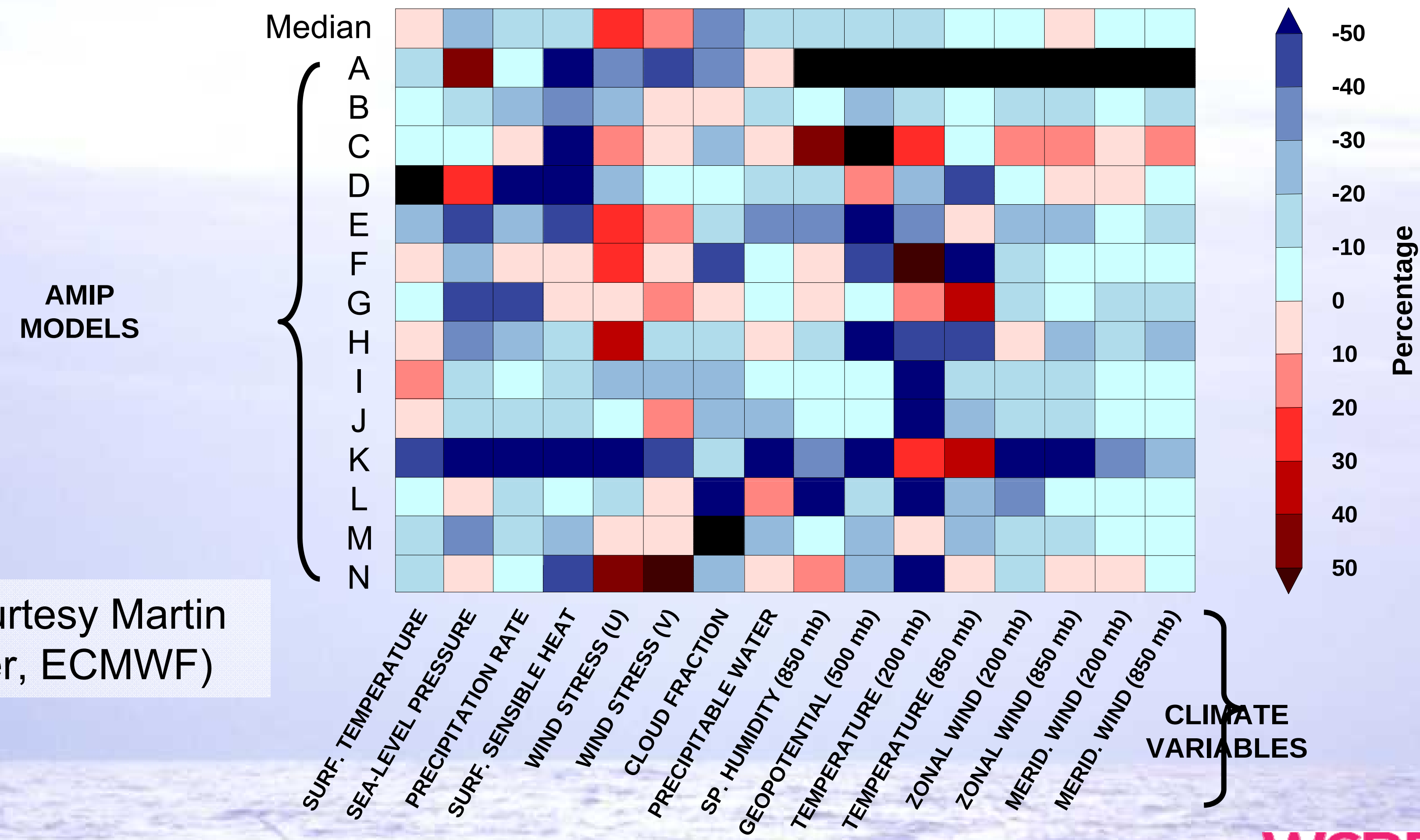
# AMIP models showed improvement during the '90s

**Annual cycle of global patterns:** Percentage change in total error: $100 \times \frac{E_{AMIP2} - E_{AMIP1}}{E_{AMIP2}}$




(Courtesy Martin Miller, ECMWF)

# The development of climate models: past, present and future

## Mid-1970s
- Atmosphere

## Mid-1980s
- Atmosphere
- Land Surface
- Ocean & Sea Ice

## Mid-1990s
- Atmosphere
- Land Surface
- Ocean & Sea Ice
- Basic chem., aerosols, $O_3$

## Present Day
- Atmosphere
- Land Surface
- Ocean & Sea Ice
- Atm. Chemistry
- Carbon Cycle
- Vegetation
- Ice Sheets

## Mid-2010s?
**Earth System:**

Physics, Biogeo-chemistry, Biology

of the

atmosphere, oceans, land, cryosphere

+

elements of human dimensions

(Interactive) Hydrology

Ocean Biology

Community

WCRP Modelling Strategy

Regional Modelling & Downscaling

WCRP Modelling Summit 2008

# World Modelling Summit for Climate Prediction

(May 6-9,2008 hosted by ECMWF)

1. **Overview: societal drivers; current status of weather and climate modeling; strategies for seamless prediction; crucial hypotheses**

2. **Strategies for next-generation modelling systems: balance between resolution and complexity; balance between multi-model and unified modeling framework; issues of parameterising unresolved scales and regional models**

3. **Prospects for current high-end computer systems and implications for model code design**

4. **Strategies for model evaluation, modelling experiments, and initialization for prediction of the coupled ocean-land-atmosphere climate system**

5. **Strategies for revolutionizing climate prediction: enhancing human and computing resources; requirements and possible organizational frameworks**

# World Modelling Summit for Climate Prediction

(May 6-9,2008 hosted by ECMWF)

- **It is well recognized that if the global models, from which lateral boundary conditions for regional models are prescribed, do not have reliable simulations of planetary waves and the statistics of tropical and extratropical storms, blocking and other regional phenomena, the use of high resolution regional models to downscale regional climate change is questionable.**

**-- Is there a less questionable alternative?**

**-- Are time-slice experiments using very high resolution (as high as regional models) global atmospheric models with surface boundary conditions from global change experiments, less questionable than regional downscaling?**

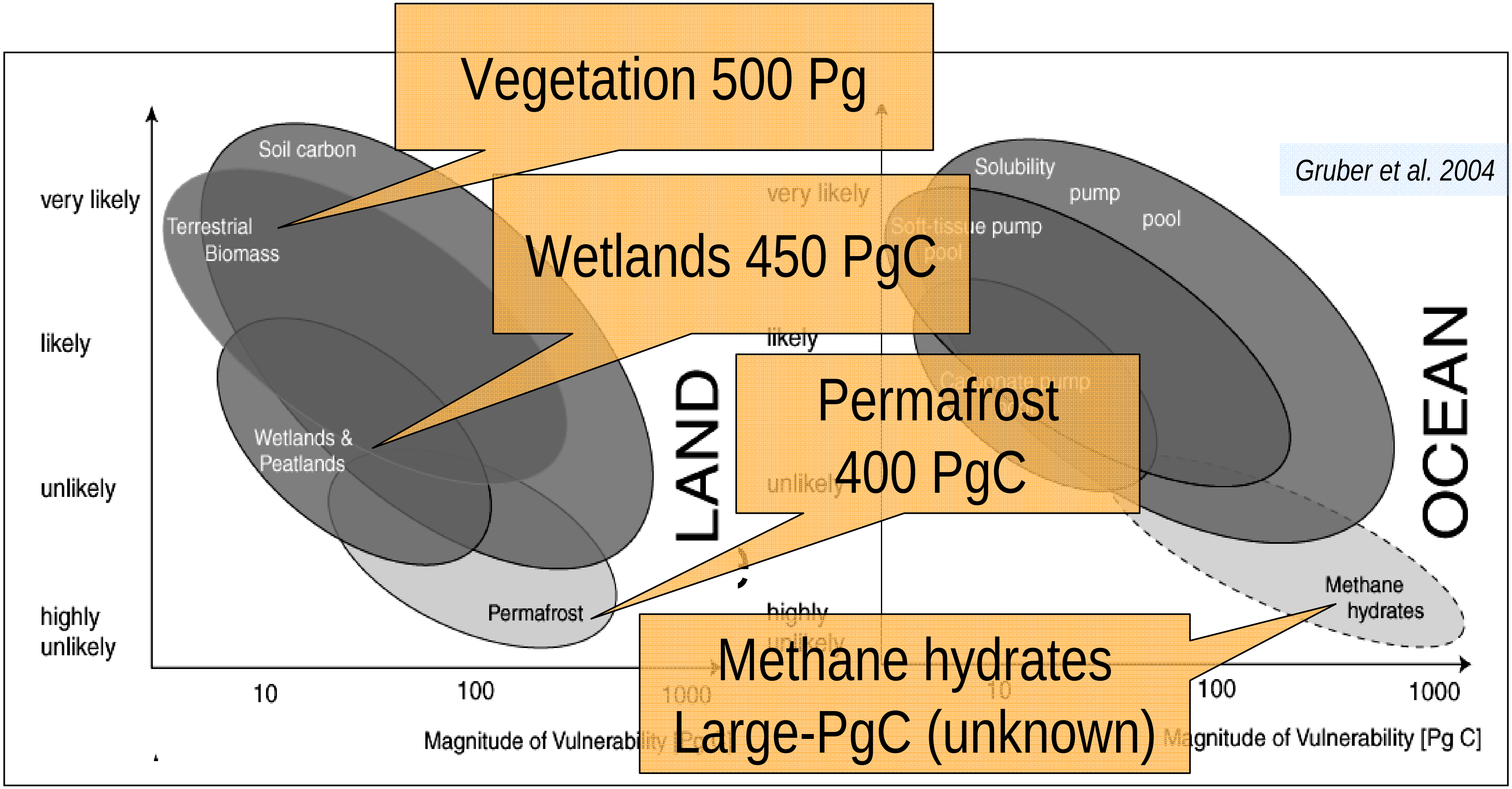
**-- How important is coupling with the ocean and land at time and space scales commensurate with those of the atmosphere model?**

**-- Are there more effective techniques available, perhaps in other disciplines, that could be employed to resolve the relevant features of the climate system?**

# Anthropogenic Climate Change (ACC)
## *The HL science issues (Sydney Wkshp)*

- **Improving and sustaining global climate observations**
- **Steady advancement of comprehensive and more realistic Earth System Models and other tools (e.g., regional-scale models)**
- **Improving the understanding of radiative forcings (esp. short-lived species, land surface) [with IGBP]**
- **Improving the understanding of feedbacks within the physical climate system and between climate and biogeochemical cycles [with IGBP]**
- **Improving treatment of convective processes and associated phenomena in models (including aerosol-cloud interactions)**
- **Variability of the climate system on different time scales, and diagnosing anthropogenic effects on natural modes**
- **Improving understanding of ice sheets and their response to global warming**
- **Global-to-regional-scale simulations/projections of changes in precipitation**
- **Extremes in climate variables (heat, precipitation, circulation)**
- **Contributing scientific understanding to the policy questions (e.g., input to SBSTA and UNFCCC)**
- **Ensuring appropriate climate change results are utilized wisely by policymakers and funders in the context of national and international adaptation to climate change**

# The tipping elements in the climate system




- Destabilisation of 1/10 of these pools would release up to 200 ppm.
- Many of these vulnerabilities are poorly treated or not included in GCMs.

# Climate Change (ACC)

## *The tipping elements in the climate system*


**(Timothy M. Lenton et al.)**

**Thank you!**



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